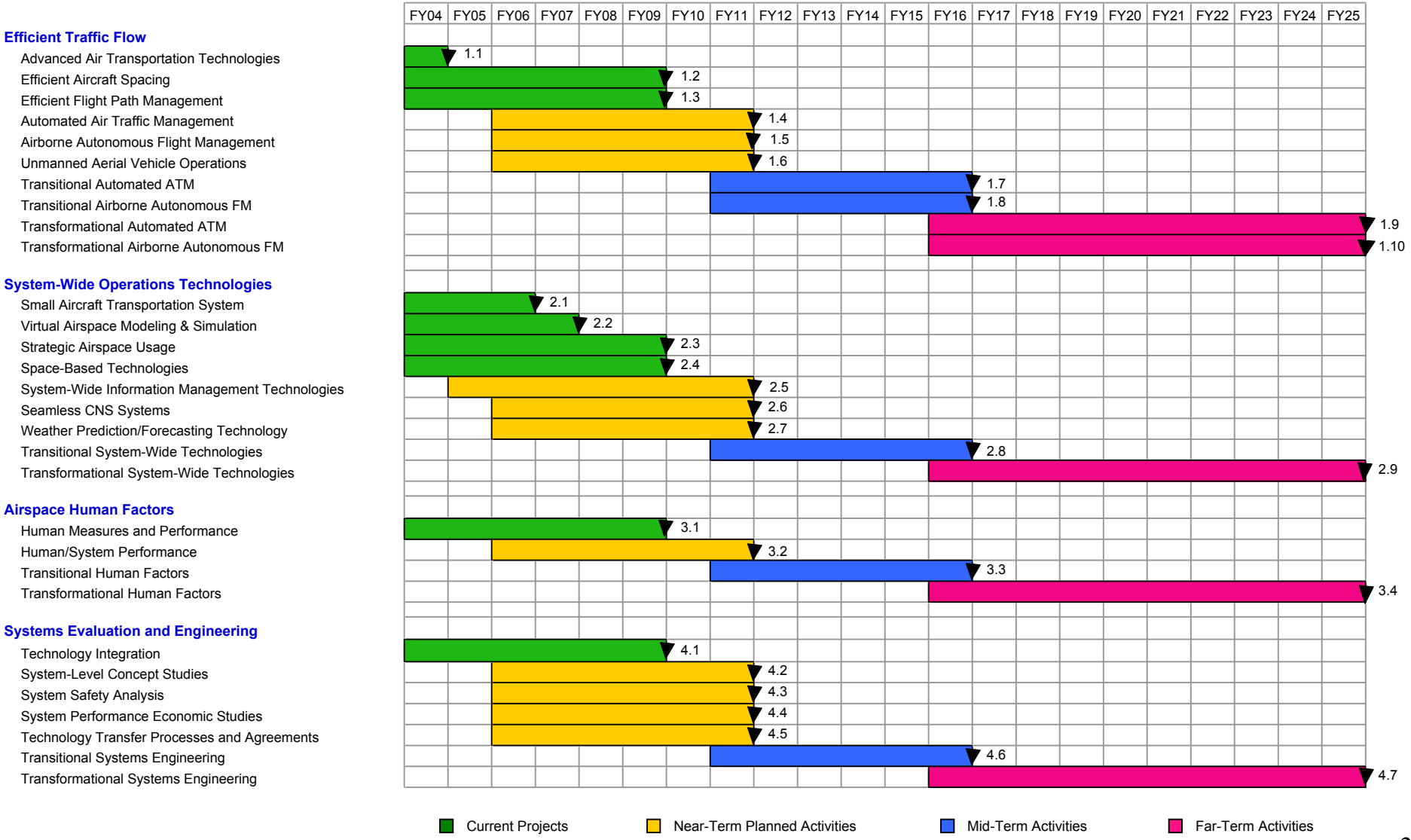
Aeronautics Technology Theme Roadmaps

January 2004

Airspace Systems Program (ASP)

Airspace Systems Projects Roadmap

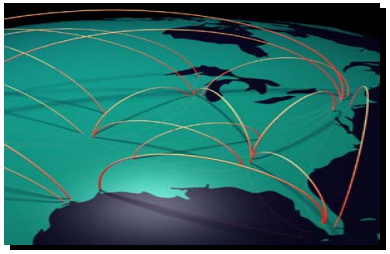
Aeronautics Technology



ASP System Concepts

Small Aircraft Transportation System

Optimum Air Traffic Management System



Next Generation Air Traffic Management System

Autonomous Operations Management System

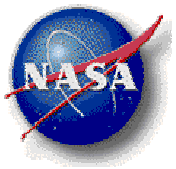
Airport Adaptive System

Demand Adaptive Management System

Arrival and Departure Management System

Surface Traffic Management System

ASP Technology-to-Capabilities Matrix

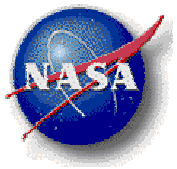


Aeronautics Technology

	Capabilities					
Strategic Technology Focus Areas	50% increase in operations through optimization and integration of national traffic flow	Elimination of 50% of delays by more efficient management of arrivals, departures, and gate assignments	Increased use of stub runways and helipads at congested hub airports	More efficient access to airspace from remote locations	Optimized spacing tailored to individual aircraft characteristics	Increased availability of direct or near-direct routings
Efficient Traffic Flow	1.1 Advanced Air Transportation Technologies 1.3 Efficient Flight Path Management 1.4 Automated Air Traffic Management 1.5 Airborne Autonomous Flight Management	1.1 Advanced Air Transportation Technologies 1.3 Efficient Flight Path Management 1.4 Automated Air Traffic Management 1.5 Airborne Autonomous Flight Management	1.2 Efficient Aircraft Spacing	1.6 Unmanned Aerial Vehicle Operations	1.1 Advanced Air Transportation Technologies 1.2 Efficient Aircraft Spacing 1.3 Efficient Flight Path Management 1.4 Automated Air Traffic Management 1.5 Airborne Autonomous Flight Management	1.1 Advanced Air Transportation Technologies 1.3 Efficient Flight Path Management 1.4 Automated Air Traffic Management
System-Wide Operations Technologies	2.3 Strategic Airspace Usage 2.7 Weather Prediction/Forecasting Technology	2.3 Strategic Airspace Usage	2.1 Small Aircraft Transportation System	2.1 Small Aircraft Transportation System 2.4 Space-Based Technologies 2.6 Seamless CNS Systems	2.3 Strategic Airspace Usage	
Airspace Human Factors						
Systems Evaluation and Engineering						

Notes: Numbered entries (e.g., 1.3) are keyed to projects in the time-phased project roadmaps. An entry in this table can be supported by multiple projects

ASP Technology-to-Capabilities, cont.

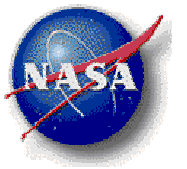


Aeronautics Technology

	Capabilities					
Strategic Technology Focus Areas	Near-instantaneous response to disruptive conditions (weather, hostile action, etc.)	Airport ground and gate operations integrated and optimized with dynamic conditions of the NAS	Accommodation of a wide variety of new vehicles in the NAS	Safe and reliable autonomy and automation in NAS	Ability to route traffic through other than congested hub airports and around choke points	Increased utilization of smaller airports
Efficient Traffic Flow	1.1 Advanced Air Transportation Technologies 1.3 Efficient Flight Path Management	1.1 Advanced Air Transportation Technologies	1.6 Unmanned Aerial Vehicle Operations	1.4 Automated Air Traffic Management 1.5 Airborne Autonomous Flight Management 1.6 Unmanned Aerial Vehicle Operations	1.1 Advanced Air Transportation Technologies 1.2 Efficient Aircraft Spacing 1.4 Automated Air Traffic Management	1.6 Unmanned Aerial Vehicle Operations
System-Wide Operations Technologies	2.3 Strategic Airspace Usage 2.7 Weather Prediction/Forecasting Technology	2.3 Strategic Airspace Usage	2.1 Small Aircraft Transportation System 2.2 Virtual Airspace Modeling & Simulation 2.4 Space-Based Technologies	2.5 System-Wide Information Management Technologies	2.2 Virtual Airspace Modeling & Simulation 2.3 Strategic Airspace Usage	2.1 Small Aircraft Transportation System
Airspace Human Factors						
Systems Evaluation and Engineering						

Notes: Numbered entries (e.g., 1.3) are keyed to projects in the time-phased project roadmaps. An entry in this table can be supported by multiple projects

ASP Technology-to-Capabilities, cont.



Aeronautics Technology

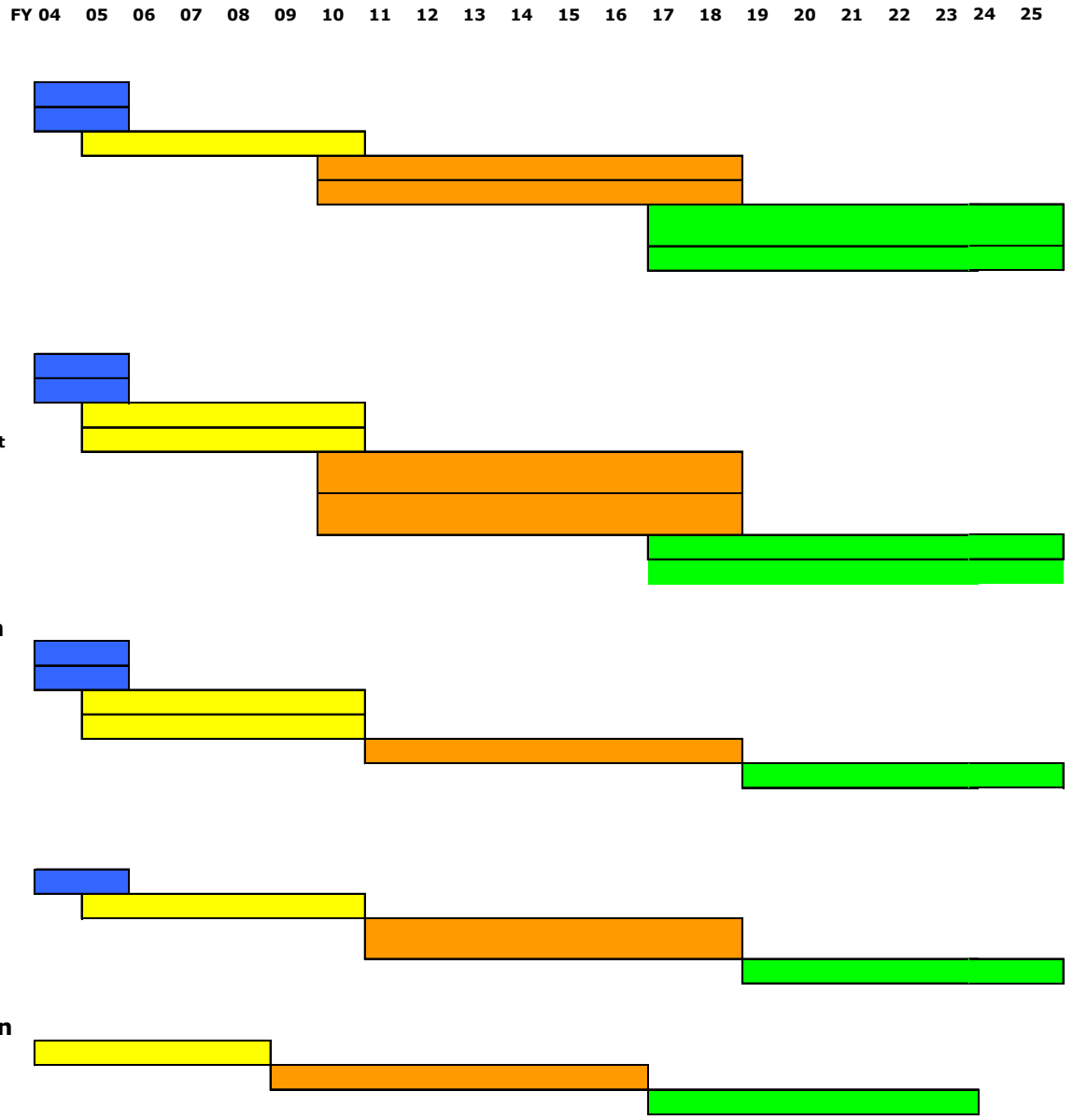
	Capabilities				
Strategic Technology Focus Areas	Multiple-aircraft operations (takeoffs, formation flight)	System designs and procedures that eliminate sources or adverse effects of human error	System-level control that enables safe expanded, high-density, and flexible utilization of airspace	System designs and procedures that eliminate sources or adverse effects of human error in future environments	Real-time assessment of state of the NAS and potential threats
Efficient Traffic Flow	1.2 Efficient Aircraft Spacing 1.3 Efficient Flight Path Management		1.2 Efficient Aircraft Spacing 1.3 Efficient Flight Path Management 1.4 Automated Air Traffic Management 1.5 Airborne Autonomous Flight Management		
System-Wide Operations Technologies	2.2 Virtual Airspace Modeling & Simulation	3.1 Human Measures and Performance	2.2 Virtual Airspace Modeling & Simulation 2.3 Strategic Airspace Usage 2.4 Space-Based Technologies	3.1 Human Measures and Performance	2.2 Virtual Airspace Modeling & Simulation
Airspace Human Factors		3.1 Human Measures and Performance 3.2 Human/System Performance		3.1 Human Measures and Performance 3.2 Human/System Performance	
Systems Evaluation and Engineering					

Notes: Numbered entries (e.g., 1.3) are keyed to projects in the time-phased project roadmaps. An entry in this table can be supported by multiple projects

Aviation Safety & Security Program (AvSSP)

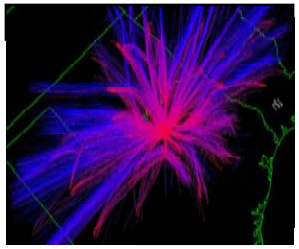
Av Safety & Security Projects Roadmap

Aeronautics Technology



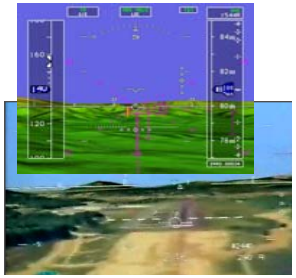
AvSSP System Concepts

Aeronautics Technology



National System Assessment & Monitoring

Self-managing Aircraft



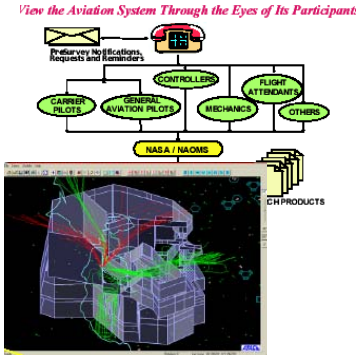
Synthetic Vision

Refuse-to-crash Aircraft

After-crash Survivable Aircraft

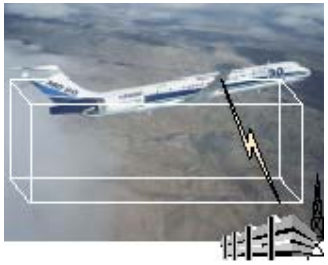
Human-error-resilient Systems

Pilot-centered Decision Toolkit

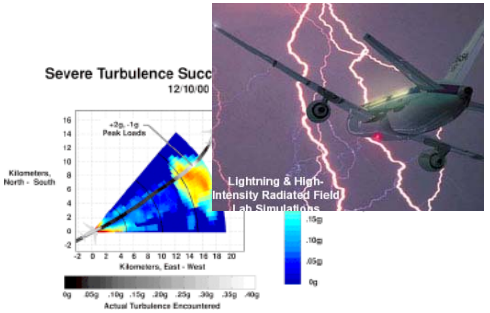


System Safety Forecasting and Analysis

Integrated Security Functions

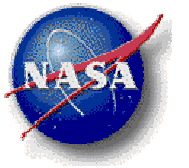


Hardened Aircraft & Systems



Weather Prediction and Threat Detection

AvSSP Technology-to-Capabilities Matrix



Aeronautics Technology

Strategic Technology Focus Areas	Capabilities							
			Note: Text in *italics* represent secondary contributions					
	Vehicles and systems resilient against historical failure causes	**Vehicles and system designs resilient against new failures and causes**	**Vehicle and system designs resilient against potential security threats**	**System designs and procedures that eliminate sources of adverse effects of human error (today or in the future)**	**Near-instantaneous response to disruptive conditions (weather, hostile action, etc.)**	**Mitigation of the consequences of accidents and incidents**	**Real-time recognition of and reaction to hostile acts**	**Mitigation of the consequences of hostile acts**
Aircraft Self-Protection & Preservation	**Aircraft & Propulsion Systems Self-Diagnosis and Self-Reliance**	**Aircraft & Propulsion Systems Self-Diagnosis and Self-Reliance**		*Aircraft & Propulsion Systems Self-Diagnosis and Self-Reliance*	**Aircraft & Propulsion Systems Self-Diagnosis and Self-Reliance**			
	Real-time Diagnosis/Prognosis	**Real-time Diagnosis/Prognosis**		*Real-time Diagnosis/Prognosis*	**Real-time Diagnosis/Prognosis**			
	Reliability-Centered Maintenance			**Reliability-Centered Maintenance**				
		Distributed adaptive control systems with real-time reconfiguration		***Distributed adaptive control systems with real-time reconfiguration***	**Distributed adaptive control systems with real-time reconfiguration**	*Distributed adaptive control systems with real-time reconfiguration*		*Distributed adaptive control systems with real-time reconfiguration*
		Self Healing Systems		*Self Healing Systems*	**Self Healing Systems**	**Self Healing Systems**		**Self Healing Systems**
Environmental Hazards Awareness & Mitigation	**Icing Technologies for Regional Jets**			*Icing Technologies for Regional Jets*	**Icing Technologies for Regional Jets**	**Icing Technologies for Regional Jets**		
	Satellite data for Real-time Aviation Weather Forecast			*Satellite data for Real-time Aviation Weather Forecast*	**Satellite data for Real-time Aviation Weather Forecast**	**Satellite data for Real-time Aviation Weather Forecast**		
	Analytical models to predict aircraft wake vortices, combined with ground senseos	*Analytical models to predict aircraft wake vortices, combined with ground senseos*		*Analytical models to predict aircraft wake vortices, combined with ground senseos*	*Analytical models to predict aircraft wake vortices, combined with ground senseos*			
	Synoptic Atmospheric data collection	**Synoptic Atmospheric data collection**		*Synoptic Atmospheric data collection*	**Synoptic Atmospheric data collection**	*Synoptic Atmospheric data collection*		
		All-weather penetration flying (hardened aircraft)		**All-weather penetration flying (hardened aircraft)**	**All-weather penetration flying (hardened aircraft)**	*All-weather penetration flying (hardened aircraft)*		
Human Error Avoidance & Mitigation	**Integrated Flight Deck Information Systems**			**Integrated Flight Deck Information Systems**				
				Training and Operations for Error Reduction	*Training and Operations for Error Reduction*		*Training and Operations for Error Reduction*	
	Augmented-Reality Flight Deck Systems	**Augmented-Reality Flight Deck Systems**		**Augmented-Reality Flight Deck Systems**	*Augmented-Reality Flight Deck Systems*		*Augmented-Reality Flight Deck Systems*	
		Single-Crew Flight Deck Technologies		**Single-Crew Flight Deck Technologies**	*Single-Crew Flight Deck Technologies*			
Hostile Act Intervention & Protection			**Aircraft & Systems Vulnerability Mitigation**		**Aircraft & Systems Vulnerability Mitigation**	*Aircraft & Systems Vulnerability Mitigation*	**Aircraft & Systems Vulnerability Mitigation**	**Aircraft & Systems Vulnerability Mitigation**
	Refuse to crash aircraft	*Refuse to crash aircraft*	**Refuse to crash aircraft**	*Refuse to crash aircraft*		**Refuse to crash aircraft**		**Refuse to crash aircraft**
		Self-recovering (landing) aircraft	**Self-recovering (landing) aircraft**	*Self-recovering (landing) aircraft*	**Self-recovering (landing) aircraft**	**Self-recovering (landing) aircraft**	**Self-recovering (landing) aircraft**	**Self-recovering (landing) aircraft**
System Vulnerability Discovery & Mangement			**System Vulnerability Detection**			*System Vulnerability Detection*	**System Vulnerability Detection**	
			Automated passenger identification and threat assessment system			*Automated passenger identification and threat assessment system*	**Automated passenger identification and threat assessment system**	*Automated passenger identification and threat assessment system*
			System vulnerability and risk prediction		*System vulnerability and risk prediction*	**System vulnerability and risk prediction**	**System vulnerability and risk prediction**	*System vulnerability and risk prediction*

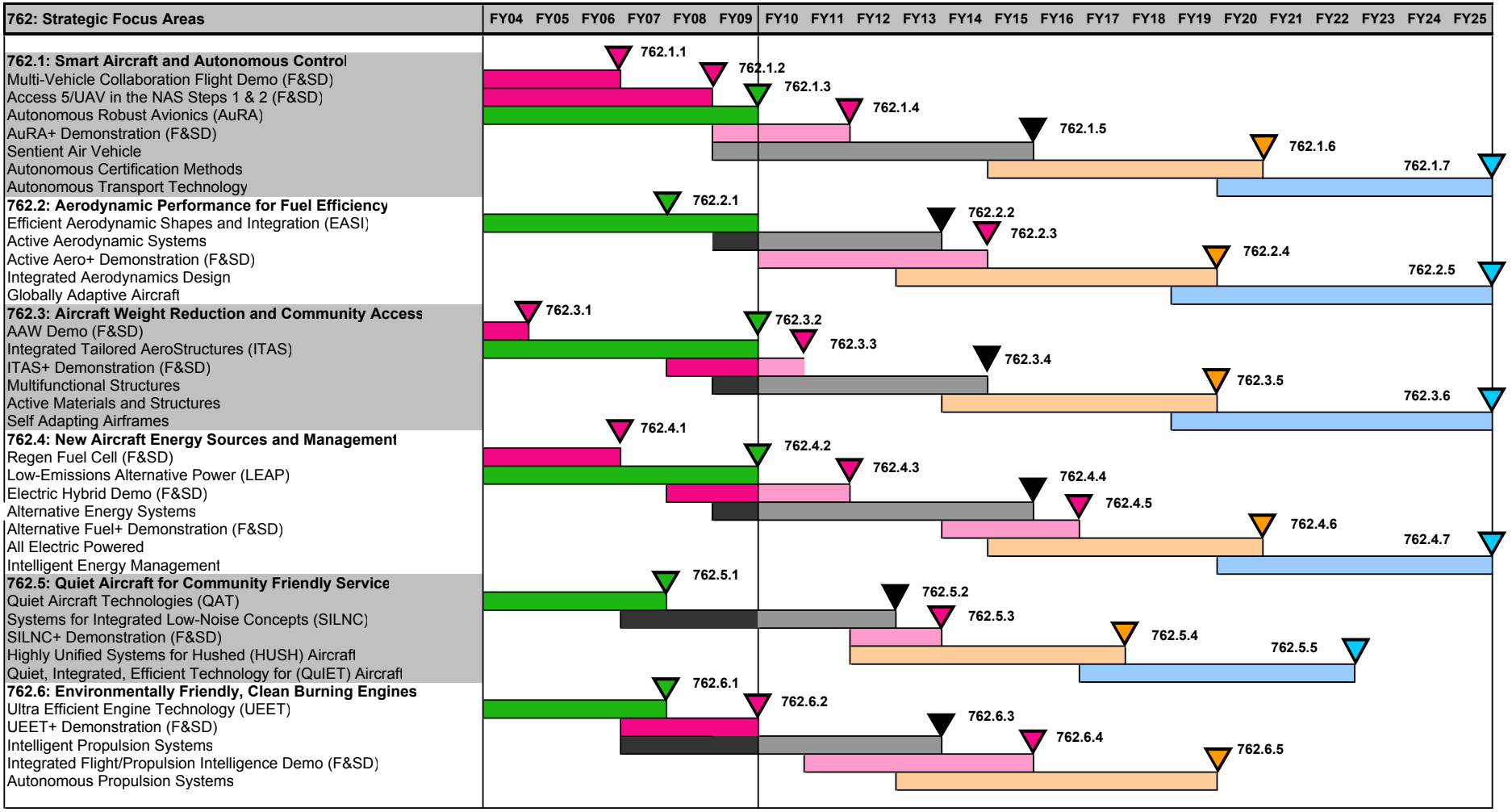
AvSSP Technology-to-Capabilities, cont.

	Capabilities							
Strategic Technology Focus Areas			Note: Text in *italics* represent secondary contributions					
	More reliable air vehicles and systems	**Lower operations and maintenance costs**	**50% increase in operations through optimization and integration of national traffic flow**	**Elimination of 50% of delays by more efficient management of arrivals, departures, and gate assignments**	**Safe and reliable autonomy and automation in NAS**	**Real-time assessment of the state of the NAS and potential threats**	**Ability to route traffic through other than congested hub airports and around choke points**	**Multiple-aircraft operations (take-offs, formation flying)**
Aircraft Self-Protection & Preservation	**Aircraft & Propulsion Systems Self-Diagnosis and Self-Reliance**	**Aircraft & Propulsion Systems Self-Diagnosis and Self-Reliance**			*Aircraft & Propulsion Systems Self-Diagnosis and Self-Reliance*			
	Real-time Diagnosis/Prognosis							
		Reliability-Centered Maintenance						
	Distributed adaptive control systems with real-time reconfiguration				*Distributed adaptive control systems with real-time reconfiguration*			
Environmental Hazards Awareness & Mitigation			*Icing Technologies for Regional Jets*	**Icing Technologies for Regional Jets**	*Icing Technologies for Regional Jets*			
			Satellite data for Real-time Aviation Weather Forecast	*Satellite data for Real-time Aviation Weather Forecast*	*Satellite data for Real-time Aviation Weather Forecast*			
			Analytical models to predict aircraft wake vortices, combined with ground senseos	*Analytical models to predict aircraft wake vortices, combined with ground senseos*				*Analytical models to predict aircraft wake vortices, combined with ground senseos*
			Synoptic Atmospheric data collection	*Synoptic Atmospheric data collection*				
	All-weather penetration flying (hardened aircraft)		**All-weather penetration flying (hardened aircraft)**				*All-weather penetration flying (hardened aircraft)*	
Human Error Avoidance & Mitigation				*Integrated Flight Deck Information Systems*	*Integrated Flight Deck Information Systems*		*Integrated Flight Deck Information Systems*	*Integrated Flight Deck Information Systems*
					Training and Operations for Error Reduction			
				Augmented-Reality Flight Deck Systems	*Augmented-Reality Flight Deck Systems*		*Augmented-Reality Flight Deck Systems*	*Augmented-Reality Flight Deck Systems*
					Single-Crew Flight Deck Technologies			
Hostile Act Intervention & Protection					*Aircraft & Systems Vulnerability Mitigation*	*Aircraft & Systems Vulnerability Mitigation*		
	Refuse to crash aircraft				*Refuse to crash aircraft*			
	Self-recovering (landing) aircraft				*Self-recovering (landing) aircraft*			
System Vulnerability Discovery & Mangement					*System Vulnerability Detection*	**System Vulnerability Detection**		
					Automated passenger identification and threat assessment system	**Automated passenger identification and threat assessment system**		
					System vulnerability and risk prediction	**System vulnerability and risk prediction**		

Vehicle Systems Program (VSP)

Vehicle Systems Projects Roadmap

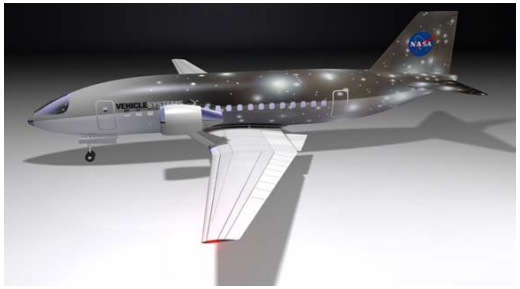
Aeronautics Technology



Notes: Numbered milestones (e.g., ▽3.3) are keyed to elements in the technologies-to-capability matrix.
Not all milestones appear in the technologies-to-capability matrix – some projects support successor projects.

VSP System Concepts

ExSTOL - Extreme Short TakeOff and Landing Transport



<2000' TOFL, M=0.8 cruise, quiet, V_{mceo} ~50kts

EQuiPT -Easy-to-use, Quiet Personal Transportation

-30 dB vs. SOA, auto-like ease of use, $75K

HeVSTOL - Heavy-Lift Vertical/Short Takeoff and Landing

120-passenger, 1,200nm, V/STOL

S⁴T - Silent Small SuperSonic Transport

Overland supercruise with acceptable sonic boom

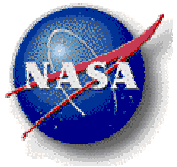
QuEST - Quiet, Efficient Subsonic Transport

Low-noise, low-emission, highly efficient transport aircraft

HALE ROA – High-Altitude Long-Endurance Remotely-Operated Aircraft

14-day endurance, 60-70K ft ops, 400 lb payload

VSP Technology-to-Capabilities Matrix



Strategic Technology Focus Areas	Capabilities					
	EQuiPT	**HeVSTOL**	**ExSTOL**	**S^{4}T**	**QuEST**	**HALE-ROA**
762.1: Smart Aircraft and Autonomous Control						762.1.1: Improve reliability of commercial UAVs by a factor of 2.
762.2: Aerodynamic Performance for Fuel Efficiency					762.2.1: Demo airframe component technologies to reduce aircraft CO2 emissions by 25%.	
762.3: Aircraft Weight Reduction and Community Access			762.3.1: Integration of advanced materials, adaptive structures and aerodynamics and active flow control for enhanced mobility enabled by short field landing & takeoff.			
762.4: New Aircraft Energy Sources and Management				762.4.1: Demo additional 10% (above the 15% from UEET) improvement in conventional propulsion systems (CO2 reduction) while laying the foundation for proof of non-conventional power and propulsion systems that double the efficiency of today's capabilities.		
762.5: Quiet Aircraft for Community Friendly Service					762.5.1: Develop & validate techs to reduce community noise impact by half relative to 1997.	
762.6: Environmentally Friendly, Clean Burning Engines				762.6.1: Demonstrate combustor configurations for reducing NOx emission by 70% (ref. to 1996 ICAO standard) to reduce smog and lower atmospheric ozone. Demonstrate airframe and engine component technologies for reducing CO2 emissions by 25% (ref. to 2000 SOA).		